Letter of MARSDEN MANSON, C. E., City Engineer,

TRANSMITTING

REPORTS

ON AN

Auxiliary Water Supply System
FOR FIRE PROTECTION

FOR

SAN FRANCISCO, CALIFORNIA

AND

MAP SHOWING PROPOSED SYSTEM

Issued by Order of the Board of Supervisors
JOHN E. BEHAN, Clerk.

BOARD OF PUBLIC WORKS, BUREAU OF
ENGINEERING.

San Francisco, Cal., March 16, 1908.

To the Honorable the Board of Public Works
Of the City and County of San Francisco—

GENTLEMEN: I have the honor to transmit herewith the report of Assistant Engineer H. D. H. Connick and Consulting Engineer T. W. Ransom on a Municipal Fire Protection System. This work has been done by authority of Ordinance No. 353 (New Series) Jan. 29th, 1908. The greater portion was done under the general direction of my predecessor, Mr. T. P. Woodward. I have, however, gone carefully over the work of Messrs. Connick and Ransom and it affords me pleasure to commend the skill and thoroughness which they have brought to bear upon the problem. No detail, experience, nor principle developed elsewhere has been overlooked, as will be made manifest by a study of their report. This study embraces a wide range of the literature of fire loss and earthquake damage, the means taken to prevent them and the practical application of these means to the requirements developed by the disaster of April 18-21, 1906.

There is also transmitted through Mr. William J. Dutton, Chairman Committee on Fire Department and Water Supply

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taken from the Building

of the Executive Committee of the Board of Fire Underwriters of the Pacific, the report of

Mr. W. C. Robinson, Chief Engineer,
Underwriters Laboratories, Incorporated.

This report reviews from the highest technical standpoint the features and details of the Fire Protection System herein submitted. It is gratifying that from so high an authority the following commendation is made: "**As I stated at the beginning of this report, I now reiterate at its conclusion, my opinion that the proposition for an auxiliary water system for fire protection in San Francisco as covered by the engineers' report, is the one best suited to the present needs of the City; one which will prove of lasting benefit to the community, and if efficiently operated, show itself to be a wise investment in the curtailment of loss by fire and in the substantial recognition such curtailment must receive from the Fire Insurance Companies doing business in San Francisco.**"

In reference to the minor suggestions offered by Mr. Robinson; the location of hydrants proposed by Messrs. Connick and Ransom is intended as tentative only, the suggestions regarding the pumping stations will receive careful consideration in the preparation of the final plans, additional hydrants and other connections may be installed at any time after the completion of the system should it prove necessary.

The great problems of fire protection in this city are severely conditioned in certain restricted areas with the risk of possible damage to the water mains by earthquake. These areas have been defined, and, provided with their own distributing system which will guard the rest of the pipe system against loss of water and pressure in the event of ruptures in the filled-in areas. There are also provided in these areas a limited supply in underground cisterns, and furthermore, they can partly be reached effectively by lines of hose from fire boats or from the adjacent solid ground.

As will be indicated later it is recommended to still farther reduce fire, conflagration and earthquake hazards in these areas by preventive measures of the highest efficiency, and, to extend these measures far more extensively than at present to all parts of the City.

CONDITIONS WHICH MAKE IT NECESSARY TO INSTALL A FIRE PROTECTION SYSTEM IN THIS CITY.

The inadequacy of the present water supply, the small size of the distributing mains, which were not designed for the high pressure now required, the combustible nature of our buildings, the topographical and climatic conditions and the liability to earthquakes make an extensive fire protection system necessary in this City.

Since our great losses on April 18-21, 1906, the price of insurance has been raised to such a figure that it is a severe handicap to all business and imposes upon this community a burden of over $4,000,000.00 annually. The necessity of reducing this makes it imperative that both protective and preventive measures of the highest efficiency be provided; for only by the use of such measures can the great losses of the disaster of April 18-21, 1906, be made of practical and profitable use. As the protective system will benefit both the insurer and the insured, the cost should be borne by both. As the interest on the necessary bond issue and sinking fund must be provided by a general tax upon the homes, properties and industries of the City, the owners should be guaranteed a very substantial reduction of the price of insurance upon the installation of the system herein proposed. The cost will then be more equitably distributed and within a few years will be returned to each through reduction of the destruction by fire.

After a study of the various possible and proposed methods of fire protection, Messrs. Connick and Ransom determined that the most efficient system is to lay cast-iron mains buried about five feet below the surface of the streets under sufficient pressure to render the use of portable steam pumping engines or fire engines unnecessary. Such a system will be always ready for instant use, in fact, in many cases, it may be used even before the arrival of the fire department. By dispensing with the use of heavy fire engines, the department will be able to reach a fire and apply water to it more quickly than at present. All the water that the department can use will be available in all parts of the protected districts. With the precautions which are provided against damage by earthquake, this system may be relied upon to offer a greater resistance to destruction than the majority of the buildings which it is designed to protect.

On account of the rapid deterioration of pipes exposed to salt water and the damage to stocks of goods which the use of salt water at a small fire would entail, it has been decided to use fresh water under ordinary conditions and salt water only in the event of exceptionally large fires.

CAPACITY OF THE SYSTEM.

After consideration of the quantities of water that have been used in great fires in this country and England, it has been decided to adopt the recommendation of the Committee of Twenty of the National Board of Fire Underwriters, which requires that the system be designed so that fifteen thousand gallons of water per minute may be concentrated on any area in the congested value district of one hundred thousand square feet. The size of mains and location of hydrants have consequently been determined on this basis. This delivery of water is sufficient to cover one of the blocks in the fifty vara survey more than one foot in depth in one hour; or, the block bounded by Kearny, Post, Grant Avenue and Sutter Street can be covered 25 feet in depth in a day. As more than one fire may occur at once, or as a part of the system may be out of service, it has been considered advisable to provide for the delivery into the distributing system of more than twice the above quantity, or 43,000 gallons for thirteen hours and 28,000 gallons for sixty-four hours thereafter. This is equivalent to 52,000,000 gallons in the first twenty-four hours and 40,000,000 gallons per day thereafter, or more than is available from the works of the Spring Valley Water Company for all purposes. Working pressures up to two hundred and thirty pounds per square inch will be necessary at the hydrants in order that this water can be used to the best advantage and in order to provide for the loss of pressure through friction in the pipes of the distribution system, provision is made for static pressures up to three hundred and twenty-seven pounds.

The system which is proposed may be described as follows:

TWIN PEAKS RESERVOIRS.

Two storage reservoirs, having a combined capacity of ten million gallons will be located on Twin Peaks in the vicinity of the intersection of Twentieth street with the southerly extension of Cole street, at an elevation of seven hundred and fifty-five feet. They are to be constructed by making rock excavations and lining the sides and bottoms with concrete. Two lines of twenty-inch pipe will connect these reservoirs with the distributing system and with the upper distributing reservoir.

PROTECTED AREA.

The protected area is shown on Sheet No. 1 and lies on the easterly water shed of the peninsula between Potrero hills and the Golden Gate. It includes the entire present fire limits and nearly all of the district in which shingle roofs are prohibited. In extent it covers 5300 acres, about 8.2 square miles or nearly double *"the burned area."*

DIVISION OF PROTECTED AREA INTO TWO ZONES.

Since the pressure from these storage reservoirs will be greater than is necessary, except for the very largest fires, and since maintaining this pressure constantly on the mains will involve considerable expense and some danger, the protected area has been divided into two zones.

The lower zone will include those portions of the protected area less than one hundred and fifty feet in elevation and is 6 square miles in area. It will be supplied from a concrete reservoir having a capacity of one million gallons which is to be constructed under the roadway of Jones street between Sacramento and Clay streets and having an elevation of about 329 feet. The roof of this reservoir will be the roadway of the street and will rest upon concrete and steel beams.

As this zone includes the congested value district and the greater portion of the manufacturing and mercantile industries, it is to be girded by 14 and 18-inch mains and gridironed at frequent intervals in both directions with 12 and 14-inch mains.

The upper zone will include all those portions of the protected area, the elevation of which is more than one hundred and fifty feet and is 2¼ square miles in area. It will be supplied from a reservoir of five hundred thousand gallons capacity situated in the vicinity of Seventeenth and Ashbury streets at an elevation of about four hundred and ninety feet.

These zones and the relation of the reservoirs and pipe systems are shown on Sheet No. 1.

Each of these zones is to be supplied with water under pressure up to one hundred and fifty pounds from its own distributing reservoir located at considerably less elevation than the main storage reservoir, as mentioned above. When necessary the mains of the upper zone may be connected with the Twin Peaks reservoirs and the pressure raised to two hundred and eighty-four pounds or less, depending upon the elevation.

The mains of the lower zone may be connected with the reservoir of the upper zone or with the Twin Peaks reservoirs whenever pressures higher than ordinary are required. Both zones are thus commanded by ordinary pressures for general use and high pressures for emergencies. In addition, salt water stations and fire boats are designed to pump either against the lower ordinary pressures or against the highest pressures of emergency conditions.

FRESH WATER PUMPING STATIONS.

The above named reservoirs will be filled with fresh water which will be pumped into them through the pipes of the distributing system from two stations situated near Seventh and Harrison streets and near Sixteenth and Shotwell streets respectively. The capacity of each station will be 1050 gallons per minute or one and one half million gallons per day. A number of wells will be sunk in the streets in the vicinity of each station and water pumped from them to a concrete cistern under the station by means of air lift pumps. Centrifugal pumps will draw the water from these cisterns and deliver it into the distributing system under sufficient pressure to force it through the pipes to the desired reservoir. As these stations are intended only to fill the reservoirs and to supply evaporation and leakage, a few hours interruption in their running will have no material effect on the efficiency of the system. They will, therefore, be operated by electric motors using current from the power wires of the local electric companies.

The quantity of water stored in the above reservoirs is about twice the amount that was used in controlling the Baldwin Hotel fire, which was one of the largest in the history of this City; it is, therefore, evident that it will be sufficient to control all but the very largest fires or a general conflagration.

.SALT WATER EMERGENCY SUPPLY.

To guard against these emergencies, two salt water pumping stations are to be provided on the water front and two large fire boats which can be used independently or be connected with the pipe system. One of the pumping stations will be situated in the vicinity of Second and Townsend streets, the other will be located near the northerly termination of Van Ness avenue or Polk street. Each station is designed for an ultimate capacity of sixteen thousand gallons per minute and pumping machinery having a capacity of ten thousand gallons per minute will be installed at once.

The pumps will be of the turbine type capable of delivering water at pressures up to three hundred pounds per square inch. Consideration of the various types of motive power available shows the steam engine to be the most desirable in economy and reliability; this type has accordingly been selected. Water tube boilers will be used; they will be fitted to burn fuel oil in the furnaces.

Storage tanks for a sufficient quantity of oil to run each plant for forty-eight hours at its full ultimate capacity of sixteen thousand gallons per minute are to be provided. No effort nor expense is to be spared in the design and construction of these plants to make them earthquake proof and secure from other accidents. The total horse-power developed in each station when pumping ten thousand gallons per minute against three hundred pounds pressure will be about three thousand or six thousand for the two stations, which is more than twice the power of all of the steam fire engines, including reserve engines at present in the City.

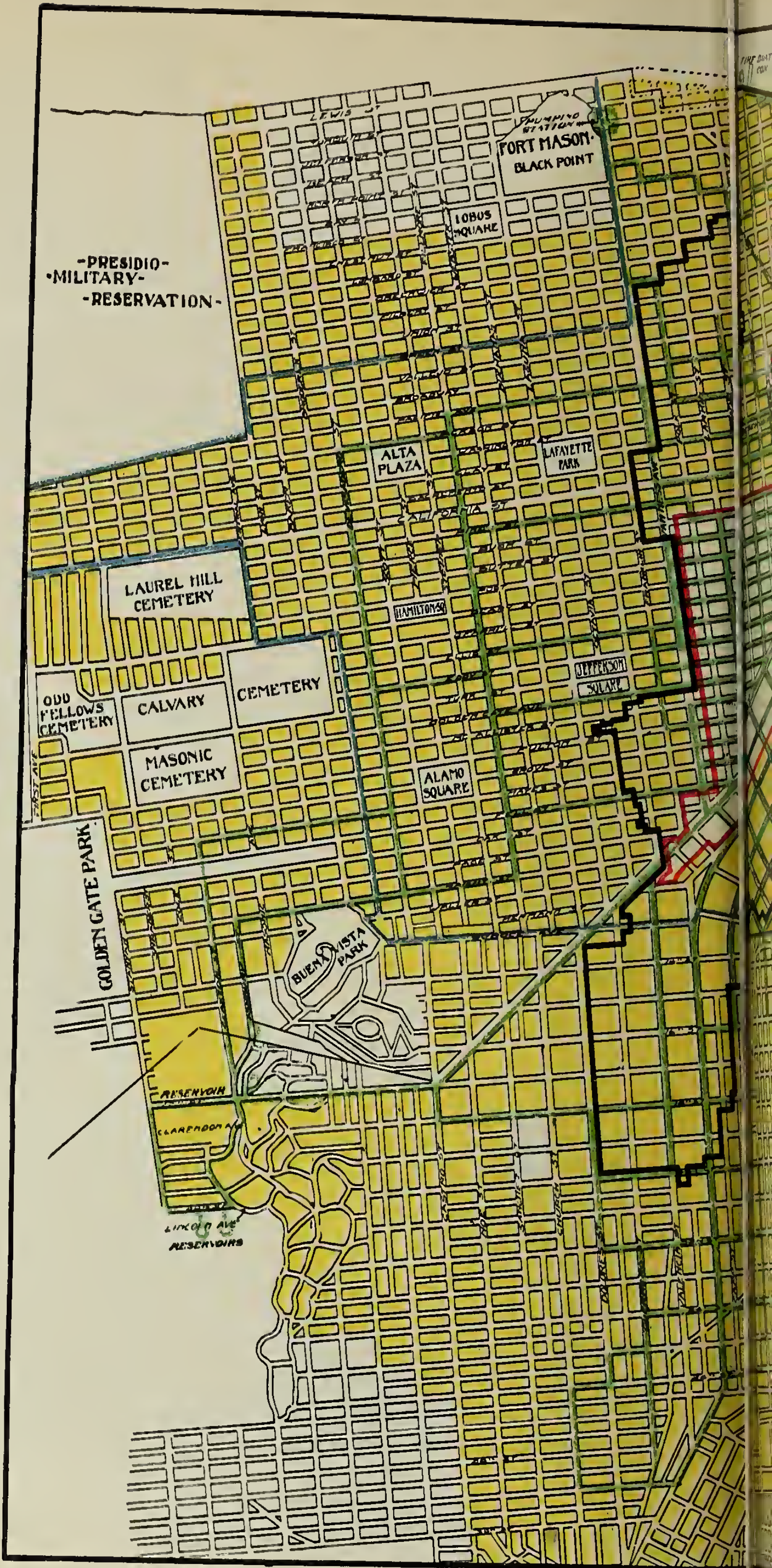
FIRE BOATS.

To protect property on the water front and to reinforce the system, if necessary, two large fire boats are to be provided. They will be about 135 feet long, 26 feet beam and 13½ feet deep. They will draw about 11 feet of water and the displacement of each will be about 520 tons. Each boat will be constructed of steel throughout and will be equipped with propelling machinery capable of driving it at a speed of about thirteen miles per hour, and with pumps capable of discharging 8,000 gallons per minute against the ordinary pressure of 150 pounds per square inch, or 4,000 gallons per minute against the emergency pressure of 300 pounds per square inch. They will be provided with every appliance to make them of the highest efficiency either independently or to reinforce the salt water emergency pumping stations. Twenty-three stations at which they may be connected to the distributing system will be provided on the water front. The concentration of the energies of both emergency salt water pumping stations and the two fire boats will enable the Fire Department to cope with a general conflagration, even in the remote and almost impossible contingency of the crippling of the mains from the reservoirs.

THE PIPE SYSTEM.

The capacity of the pipe system has been previously mentioned. The pipes and connections are to be of sufficient strength to stand the full pressure of the storage reservoir or 327 pounds per square inch, and are to be tested to double this pressure. The aggregate length is 91½ miles. Maximum size of mains 20 inches and minimum size 12 inches in diameter with 8-inch hydrant connections.

Whenever it shall be found necessary to extend the system, the machinery and mains now proposed are of sufficient capacity to permit such extensions without changing any part of the system. It will only be necessary to acquire the sites, provide the storage reservoirs and install the required cast-


LEWIS ST
PUMPING STATION
FORT MASON
BLACK POINT
LOBUS SQUARE
-PRESIDIO-
-MILITARY-
-RESERVATION-
ALTA PLAZA
LAFAYETTE PARK
CALIFORNIA ST
LAUREL HILL CEMETERY
HAMILTON SQ
JEFFERSON SQUARE
ODD FELLOWS CEMETERY
CALVARY
CEMETERY
MASONIC CEMETERY
FIRST AVE
ALAMO SQUARE
GOLDEN GATE PARK
BUENA VISTA PARK
RESERVOIR
CLARENDON AV
LINCOLN AVE RESERVOIRS
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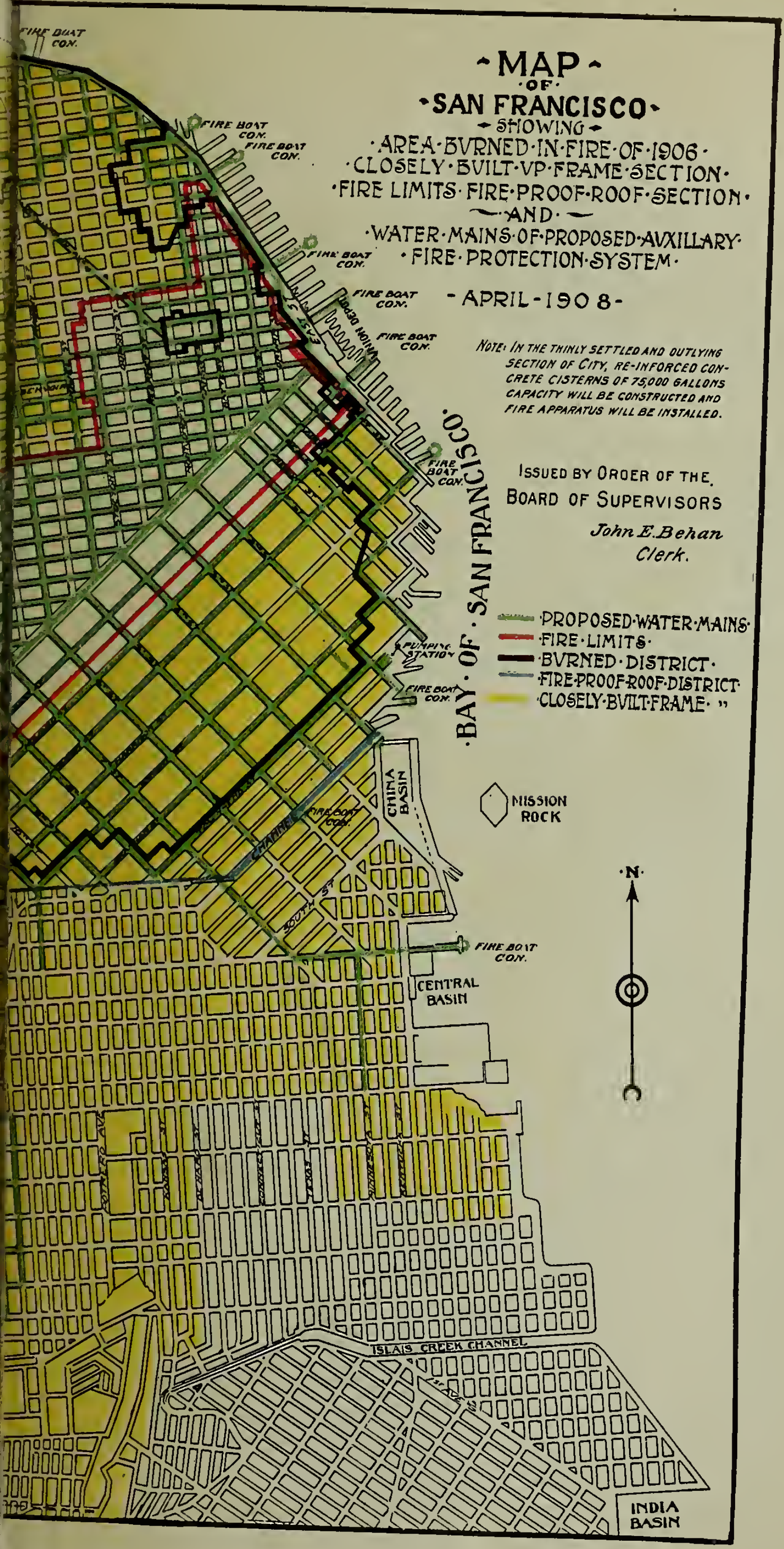

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·SAN FRANCISCO·
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·AREA·BVRNED·IN·FIRE·OF·1906·
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·AND·
·WATER·MAINS·OF·PROPOSED·AVXILLARY·
·FIRE·PROTECTION·SYSTEM·

-APRIL-1908-

Note: In the thinly settled and outlying section of City, re-inforced concrete cisterns of 75,000 gallons capacity will be constructed and fire apparatus will be installed.

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iron mains and hydrants for districts beyond the present boundaries of the protected area.

Cut-off gate valves are provided at sufficient intervals to prevent loss of pressure in the system in case of breaks in the mains through the artificially filled areas, and to cut out any block for repairs or connections without shutting off water from adjacent blocks.

The pipe, gate and hydrant systems are shown on Sheet No. 1, together with their connections with the main and distributing reservoir, the emergency salt water pumping stations and fire boat connections. Hydrants in the congested value district of the lower zone are so distributed that with maximum hose lengths of 400 feet 15,000 gallons per minute can be concentrated on any area of 100,000 square feet; in other parts of the protected area from one-half to three-fourths this volume of water can be concentrated on a block.

FIRE CISTERNS.

As an additional precaution existing fire cisterns are being cleaned out, repaired and filled and provision is made for one hundred additional ones of reinforced concrete, each having a capacity of 75,000 gallons. Sixty of these are shown on Sheet No. 3 and forty more are to be located as indicated by the Chief Engineer of the Fire Department.

TELEPHONE CONTROL AND OPERATION.

For the direction and control of the entire system 395 special telephones are provided. These are to be upon 66 independent under-ground circuits connecting with the switchboards at the pumping stations. In addition there will be connections between each of these central stations with the nearest office of the local telephone companies and with the Police and Fire System.

Two lines will run to each gatehouse and also to the stations of the fire boats.

ESTIMATED COST.

The estimated cost of this system is as follows:

Two storage reservoirs on top of Twin Peaks, capacity 10,000,000 gallons	$ 126,000 00
Distributing reservoir of Upper Zone, near 17th and Ashbury streets, capacity 500,000 gallons	17,000 00
Distributing reservoir of Lower Zone in Jones street, between Sacramento and Clay streets, capacity 1,000,000 gallons	55,000 00
Distributing system consisting of 483,558 lineal feet of cast-iron pipe with necessary specials, gate valves, gate boxes, hydrants, air valves, relief valves, blow-off valves and fire boat connections	2,900,000 00
One hundred 75,000-gallon cisterns	600,000 00
Two fresh water pumping stations	117,000 00
Two salt water pumping stations	650,000 00
Two fire boats	300,000 00
Quarters for men on wharf	10,000 00
Telephone system	125,000 00
Real estate for distributing reservoirs and pumping stations	100,000 00
Engineering, preparation of plans, specifications, testing materials and inspection of construction	200,000 00
Total	$5,200,000 00

When this system shall have been installed, San Francisco will have the most powerful and efficient engine of fire protection ever constructed. The area protected is greater by 2300 acres than that of Greater New York and the volume of water available will exceed that available either in New York or Brooklyn.

The means to be provided for the application of water to the seat of a fire will be the most modern and efficient known to fire protection engineers. The safeguards with which the system is to be surrounded to protect it or any considerable portion of it from damage by ~~earthquake or~~ accident are more extensive than have hitherto been considered necessary.

Statistics show the annual fire loss in the United States to be between 7 and 8 times as great as that in European countries. For every dollar's worth of gold and silver produced in all the mines of the United States and Alaska during the last thirty-seven years, property to the value of one dollar and fifty-two cents has been destroyed by fire during the same period. This appalling loss is accounted for by the combustible nature of our buildings and the carelessness of our citizens.

San Francisco is more exposed to fire loss than other large American cities for the following reasons: A larger proportion of our buildings are constructed of wood. The topography is such that a large number of streets are too steep to admit the rapid movement of heavy fire apparatus. During the summer months practically no rain falls and the sides and roofs of our buildings become very dry, at the same time winds having average velocities of from 14.1 miles per hour in April to 22 miles per hour in July prevail during the afternoon hours and greatly increase the danger of a fire escaping from the control of the fire department. The fire department depends for water for fire protection purposes principally upon the mains of the Spring Valley Water Company. It is recognized that the works of that company are constructed on conservative lines with large factors of safety, but partly on account of defects which can be remedied only at an expense which the company claims its income will not warrant and partly by reason of defects which are inherent the fire protection afforded is not sufficient. The pressure is too low and many of the distributing pipes are too small to permit of the delivery of sufficient quantities of water for effective fire control in all parts of the city. Many of the mains pass over ground liable to serious displacement from earthquake, and, as was shown in the conflagration of April, 1906, are a serious menace to the safety of the entire city because of insufficient gate control to guard against loss of water and preserve the rest of the system should these pipes be ruptured. Furthermore, it is not desirable in a city like San Francisco to attempt to combine a domestic supply and a fire protection system in one, as in the event of a general conflagration the loss of water through broken house connections in districts already burned over is liable to impair or destroy the efficiency of the entire system, and numerous small connections increase the earthquake hazard in the pipe system.

Although fire insurance experts have long known that these conditions render San Francisco especially liable to a great conflagration, the extreme danger of the situation was not fully appreciated until the fire of April, 1906, showed how easily the city could be destroyed. The result of that conflagration and the consequent realization of the existing conflagration hazard has been that fire insurance rates have been greatly increased and the agents of the various insurance companies have been so limited in the amount of business they are permitted to write that competition has been practically eliminated and many merchants are unable to obtain fire insurance even at such high rates as five per cent and upwards per annum. Under modern conditions such a state of affairs makes it exceedingly difficult and expensive to conduct business and will, if steps are not taken at once to reduce the conflagration hazard, seriously handicap the future growth of the city.

The comparative ease with which the recent conflagration was finally checked along Van Ness avenue and in the Mission, has created in the mind of the public an erroneous opinion as to the difficulty of controlling a general conflagration. The fire originated in the eastern part of the city and spread in a direction contrary to that in which the prevailing wind was blowing so that it was retarded rather than assisted by this wind, consequently it was checked without great difficulty, wherever even comparatively small quantities of water were available.

"*The burned area had a fire front of* 49,305 *feet or* 9.34 *miles, a water front of* 9,510 *feet or* 1.80 *miles and a total of* 58,815 *feet or* 11.14 *miles.*

Of this 49,305 *feet of frontage,* 9,540 *feet are on the wide streets or avenues—Van Ness avenue, Market and Dolores streets. The remainder,* 39,765 *feet, are on ordinary streets,* *across blocks, etc., or about 20% of the total frontage is on wide streets, and the remainder, 80% on ordinary streets, etc.''* (P. 56 Report of Sub-Committee on Statistics).

Considering these data and the fact that in the absence of a water supply, the fire crossed and re-crossed streets of the width of Market, Van Ness avenue and Dolores, the main dependence must be placed on the efficient means herein proposed.

Had the earthquake which preceded it not disabled the water supply system by breaking a number of distributing mains and house connections, the fire or fires could undoubtedly have been confined to a few buildings in the vicinities of their origin. The great danger to San Francisco is that a fire originating in the Western Addition or the Mission at a time when a strong west wind is blowing will get beyond the control of the fire department and, fanned by the wind, will be swept through the congested value district to the eastward until it reaches the bay shore. Such a disaster can be prevented only by providing water in larger quantities and at higher pressures than have hitherto been available, and by the introduction of fire preventive measures of high efficiency.

FIRE PROTECTIVE MEASURES. ✓

It is manifest that after having put in operation the most efficient and largest fire protection system in the world that but a portion of our duty will have been performed; there yet remains the necessity for reducing fire, conflagration and earthquake hazards by a far greater restriction of the use of combustible materials in buildings and the substitution therefor of absolutely non-combustible materials and the modification of the building laws so as to permit and prescribe a greater safety from damage by earthquake. These measures, while practically more necessary in the restricted areas of artificially filled lands, are also greatly needed all over the city.

It has been clearly pointed out that our risks are greater than elsewhere and that fire losses are greater in the United States than in Europe by reason of our greater use of combustible material in construction. It is, therefore, our imperative duty to the lives and interests of this city to reduce these risks, *first, by extending the fire limits, and second, by prescribing a far greater use of non-combustible materials in all building operations.* Fortunately there are sound reasons other than fire and conflagration risks in favor of this change. 1st. *Greater protection of life.* 2d. *Economy in construction.* 3rd. *A decrease in earthquake risk, and* 4th, *further reduction in insurance rates.*

Moreover, our mild climate permits us to adopt types of construction different from and cheaper than those in use in Eastern cities. It is therefore recommended

1st. That a definite study be made as to greater extension of fire limits with the particular aim of extending them over the artificially filled lands where all hazards are at a maximum.

2nd. That an entire reclassification of buildings be made and that certain types now permitted be restricted or prohibited and that others be introduced.

The proposed classification will only be indicated at present and should be fully discussed and elaborated with a view of reducing to a minimum the hazards of the lives, homes, properties and industries within our borders.

Class A buildings should be defined to include all buildings erected entirely of non-combustible materials. At the head of the list should stand Class A1. The modern steel framed building provided with every requirement of the National Board of Underwriters. Near the bottom of the list a steel framed building not exceeding two stories in height, covered and roofed with galvanized iron.

This is outlined in the following table:

CLASS A1.

Steel cage construction, concrete brick or tile walls and floors, metal framed doors, windows and finishings, plate wire glass windows, iron or asbestos curtains on exposed sides.

CLASS A2.

Concrete or brick walls, steel posts, concrete or tile covered, concrete, steel or tile floors, steel framed metal covered roof, fire shutters on exposed sides.

CLASS A3.

Reinforced concrete walls, steel framed roof, metal covered fire shutters on exposed sides.

CLASS A4.

Light steel frames, walls metal lathing or expanded metal, plastered with cement mortar on one or both sides of framework, concrete, steel or tile floors, metal roof, metal framed windows and doors, plate wire glass, asbestos curtains, for light stores or dwellings, etc.

CLASS A5.

Steel frame, corrugated iron sides and roof for sheds and lightest buildings. If more than one story, walls metal lathed and plastered, upper floors of steel and concrete or tiles. Wire glass windows and skylights.

CLASS A6.

Any combination of the above classes which are structurally sound.

Class B should include the present Class B1 and a second Class B2, suggested by City Architect Tharp, constructed of a properly proportioned and braced wooden frame with wire or expanded metal lathing plastered inside and out, and with floor protection and ceilings of the same materials. It will be observed that this building is not only earthquake proof but has high fire and conflagration resistance.

The present Class C should be strengthened as to wall ties, and restricted in size and height.

It is apparent that one of the forms of Class A or slight modifications to include it in Class B or Class B2, will largely supersede frame buildings to the advantage of the property holder, and that these can be used in the present fire limits at less expense and hazard than the present Class C.

If the improvements above outlined be made San Francisco will have but little to dread from even a more serious earthquake than that of April 18th, 1906; the possibilities of great fires will be reduced from a maximum, as at present, to a minimum; and confidence will mark our recovery and development in every line to the remotest future.

Respectfully submitted,

(Signed) MARSDEN MANSON,

City Engineer.

San Francisco, California, Jan. 31, 1908.